substantially intersecting said reference axis, said reflective surface including a reflecting means for forming a reflected light having a convergence about said reference axis; and

a refractive surface connected to said reflective surface disposed intersecting said reflected light, said refractive surface including a refracting means for bringing said reflected light towards parallelism with said reference axis.

Rule 1.126 amdt

23. A lighting device including:

a light source;

a source of electrical power;

said light source further including a light emitting diode element;

B1

said light emitting diode element coincident with a reference axis;

a connecting means for connecting said source of electrical power to said light source;

said light emitting diode element emitting a side light having a side divergence about said reference axis;

said light emitting diode element encapsulated in a lamp light transmitting medium, said lamp light transmitting medium comprising a resin having an index of refraction exceeding 1.1;

a reflective surface connected to said light source disposed intersecting said side light, said reflective surface comprising a substantially elliptical line, said substantially elliptical line having an elliptical line axis, said elliptical line axis substantially intersecting said reference axis, said reflective surface including a reflective means for forming a reflected light having a convergence about said reference axis; and

a refractive surface connected to said reflective surface disposed intersecting said reflected light, said refractive surface including a refracting means for bringing said reflected light towards parallelism with said reference axis.

Rule 1.126 amdt

24. A lighting device including:

a light source;

a source of electrical power;

said light source further including a light emitting diode element;

said light emitting diode element coincident with a reference axis;

a connecting means for connecting said source of electrical power to said light source;

said light emitting diode element emitting a side light having a side divergence about said reference axis;

said light emitting diode element encapsulated in a lamp light transmitting medium, said lamp light transmitting medium comprising a resin having an index of refraction exceeding 1.1;

B1

a refractive surface;

a reflective surface;

said lamp light transmitting medium forming said reflective surface and said refractive surface;

said reflective surface connected to said light source disposed intersecting said side light, said reflective surface comprising a substantially elliptical line, said substantially elliptical line having an elliptical line axis, said elliptical line axis substantially intersecting to said reference axis, said reflective surface including a reflective means for forming a reflected light having a convergence about said reference axis; and

said refractive surface connected to said reflective surface disposed intersecting said reflected light, said refractive surface including a refractive means for bringing said reflected light towards parallelism with said reference axis.

Rule 1.116 Amd.

28. A lighting device including;

a light source;

a source of electrical power;

said light source further including a light emitting diode element;

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a connecting means for connecting said source of electrical power to said light source;

said light emitting diode element coincident with a reference axis and emitting a forward light having a forward divergence about said reference axis;

said light emitting diode element encapsulated in a lamp light transmitting medium, said lamp light transmitting medium comprising a resin having an index of refraction exceeding 1.1;

a lens surface;

said lens surface formed of said lamp light transmitting medium and disposed about said light source intersecting said forward light, said lens surface including a lens means for refracting and bringing said forward light towards parallelism with said reference axis;

said light emitting diode element further emitting a side light having a side divergence about said reference axis;

said side divergence larger than said forward divergence;

a reflective surface connected to said light source disposed intersecting said side light, said reflective surface comprising a substantially elliptical line, said substantially elliptical line having an elliptical line axis, said elliptical line axis substantially intersecting said reference axis, said reflective surface including a reflective means for forming a reflected light having a convergence about said reference axis; and

a refractive surface connected to said reflective surface and disposed intersecting said reflected light, said refractive surface including a refractive means for bringing said reflected light towards parallelism with said reference axis.

Rule 1.126

26. A lighting device including:

a light source;

a source of electrical power;

said light source further including a light emitting diode element;

said light emitting diode element coincident with a refer-

ence axis;

a connecting means for connecting said source of electrical power to said light source;

said light emitting diode element emitting a side light having a side divergence about said reference axis;

said light emitting diode element encapsulated in a lamp light transmitting medium, said lamp light transmitting medium comprising a resin having an index of refraction exceeding 1.1;

a refractive surface;

a reflective surface;

a sleeve means formed of a sleeve light transmitting medium;

said sleeve means comprising said refractive surface and said reflective surface, said sleeve means further comprising a wall forming a hollow portion, said hollow portion receiving said light source;

said reflective surface connected to said light source disposed intersecting said side light, said reflective surface comprising a substantially elliptical line, said substantially elliptical line having an elliptical line axis, said elliptical line axis substantially intersecting said reference axis, said reflective surface including a reflective means for forming a reflected light having a convergence about said reference axis; and

said refractive surface connected to said reflective surface disposed intersecting said reflected light, said refractive surface including a refractive means for bringing said reflected light towards parallelism with said reference axis.

27. A lighting device including;

a light source;

a source of electrical power;

said light source further including a light emitting diode element;

said light emitting diode element coincident with a reference axis;

a connecting means for connecting said source of electrical power to said light source;

said light emitting diode element emitting a side light having a side divergence about said reference axis;

a reflective surface formed of a rotary movement of a substantially elliptical line about said reference axis;

said reflective surface connected to said light source disposed intersecting said side light, said substantially elliptical line having an elliptical line axis, said elliptical line axis substantially intersecting said reference axis, said substantially elliptical line having a focal point, said light emitting diode element located substantially at said focal point; and

a refractive surface connected to said reflective surface disposed intersecting said reflected light, said refractive surface including a refractive means for bringing said reflected light towards parallelism with said reference axis.

Rule 1.126 M.H. 7

28. The lighting device according to any of claims 1, 2, 3, 25 or 27 which further includes:

a lens surface;

said light emitting diode element further emitting a forward light having a forward divergence about said reference axis;

said forward divergence less than said side divergence; and

said lens surface formed of a light transmitting medium connected to said light source and disposed about said light source intersecting said forward light, said lens surface including a lens means for refracting said forward light and reducing said forward divergence of said forward light about said reference axis.

Rule 1.126.449 M.H. 8

29. The lighting device according to any of claims 1, 2, 4, 25 or 27 which further includes:

a sleeve means formed of a sleeve light transmitting medium; and

said sleeve means comprising said refractive surface and said reflective surface, said sleeve means further comprising a wall forming a hollow portion , said hollow portion receiving said light source.

Rule 1.126 9 M.H. 45 30. The lighting device according to any of claims 1 2 3 37 38 39 22, 23, 24 or 27 which further includes:

a lens surface;

said light emitting diode element further emitting a forward light having a forward divergence about said reference axis;

said forward divergence smaller than said side divergence;

said lens surface formed of a light transmitting medium coupled to said light source and disposed intersecting said forward light; said lens surface including a lens means for refracting said forward light and reducing said forward divergence about said reference axis;

a sleeve means formed of a sleeve light transmitting medium;

said sleeve means comprising said refractive surface and said reflective surface, said sleeve means further comprising a wall forming a hollow portion, said hollow portion receiving said light source; and,

a wall light transmitting medium with an index of refraction exceeding 1.1 between said wall and said light source.

Rule 1.126 10 M.H. 46 31. The lighting device according to any of claims 1 37 22 thru 5 41 26 which further includes:

said reflective surface formed of a rotary movement of said substantially elliptical line about said reference axis.

Rule 1.126 11 M.H. 47 32. The lighting device according to any of claims 1 37 22 thru 5 41 26 which further includes:

said reflective means comprising said substantially elliptical line having a focal point and said light emitting diode element located substantially at said focal point.

PATENT OPERATIONS

Rule 1.126 M.H. 12 — 1 37 6 42

~~33~~. The lighting device according to any of claims ~~22~~ thru ~~27~~ which further includes:

said refractive means additionally for bringing said reflected light approximately to parallelism.

Rule 1.126 M.H. 13 — 1 37 6 42

~~34~~. A lighting device according to any of claims ~~22~~ thru ~~27~~ which further includes:

said refractive means comprising said refractive surface having a concave contour.

Rule 1.126 M.H. 14 — 1 37 6 42

~~35~~. A lighting device according to any of claims ~~22~~ thru ~~27~~ which further includes:

B' said refractive surface formed of a rotary movement of a line about said reference axis, said line intersecting said reference axis forming an acute angle.

Rule 1.126 M.H. 15 — 1 37 6 42

~~36~~. A lighting device according to any of claims ~~22~~ thru ~~27~~ which further includes:

said refractive means comprises said refractive surface formed of a rotary movement of a curved line approximately about said light emitting diode element.

Rule 1.126 M.H. B2 16 — 1 37 2 38 4 40

~~37~~. A lighting device according to any of claims ~~22~~, ~~23~~ or ~~25~~ which further includes:

said reflective surface and said refractive surface formed of a light transmitting medium having an index of refraction exceeding 1.1.

Rule 1.126 M.H. 17 — 4 40

~~38~~. A lighting device according to claim ~~25~~ which further includes:

said lens means comprising said lens surface having a substantially aspheric contour.

PATENT OPERATIONS

2. Also please add the following paragraph to Section 3A of our 12/02/97 amendment as follows:

Section 3A of an amendment dated 12/02/97 provided 5 numbered reasons why prior art Harris would not be added to Sakai to create the current application. There is an additional reason number 6 which teaches against adding Sakai to Harris - - reason #6 follows:

6. Looking at FIG. 9 of Sakai one sees that he expects light emitted in the θ2 region to exhibit intensities exceeding .5 or 50 percent of the maximum intensity. Looking at FIGs. 1 and 5 it can also be seen that the parabolic reflector of Sakai intersects and collects all of the emitted light shown in FIG. 9 including the light of region θ2 (extending from between 90 degrees to 70 degrees off-axis X).

Now refer to FIG. 7 of Harris (2,254,961). Although FIG. 7 claims to collect all of the emitted light a close look shows that if a light source were installed in FIG. 7 the light in the θ2 region (extending from between 70 degrees to 90 degrees off-axis X) would first strike reflector 28 and then miss refractor 31. It would be lost. It would be misdirected as refractor 31 is necessary to adjust its direction and bring it towards parallelism with the axis.

Thus the combination of Sakai and Harris would design against the Sakai objective of collecting all of the light between 0 - 90 degrees off-axis. It does not improve the design with the Sakai FIG. 9 LED. The FIG. 7 optics of Harris would if added to Sakai waste light that is presently collected by the parabola and non refractor of Sakai.

Thus aside from the absence of a positive motivation to add Harris to Sakai there is actually a negative motivation. The combination will waste the light in the Sakai θ2 region.

Although as the current invention can function with a variety of LED elements one excellent embodiment is with an emitter that has a spatial radiation pattern which follows the cosine law

(see page 4, lines 13-15) of the current application. For this emitter, the intensity at 90 degrees is zero (unlike the 50 percent of Sakai FIG. 9). Because of this the current invention can employ a reflector 12 as shown in FIG. 5 which collects only up to 70 degrees off-axis light (see page 13, lines 22-23 and page 12, lines 25-26 which disclose angle A8 plus angle A9 total 70 degrees) and maintain a high efficiency.

Thus, the fact that LED elements have a unique directional spatial radiation pattern creates a situation where their corresponding optics are potentially different from the optics employed for a uniform emitter such as an incandescent lamp and also potentially different from other LED lamps. Within the LED lamp community there are a variety of spatial radiation patterns. Hence the choice of a particular LED pattern can determine the optimum optics for a design. Sakai designed his optics for his FIG. 9 LED spatial radiation pattern. Applicant's design is optimized for a prior art LED emitter similar to Sakai FIG. 8 or a cosine emitter.

Sakai employs in his patent a FIG. 9 spatial radiation pattern that emits a reasonable amount of energy into his θ2 region and because of this is required to collect light up to 90 degrees off-axis X. The current invention works best with a cosine emitter. The LED spatial radiation selected by applicant permits his design to tilt or angle the reflector because he does not emit appreciable energy into the θ2 region. Applicant does not have to collect from 70 to 90 degrees off-axis.

3. Delete Tables I and II previously provided in an amendment of 11/27/97 and substitute supplemental Tables I and II enclosed.